NI 5670 RF Vector Signal Generator

Getting Started Guide

January 2004 Edition
Part Number 323537A-01

Worldwide Technical Support and Product Information

ni.com

National Instruments Corporate Headquarters

11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel: 512 683 0100

Worldwide Offices

Australia 1800 300 800, Austria 43 0 662 45 79 90 0, Belgium 32 0 2 757 00 20, Brazil 55 11 3262 3599,
Canada (Calgary) 403 274 9391, Canada (Ottawa) 613 233 5949, Canada (Québec) 450 510 3055,
Canada (Toronto) 905 785 0085, Canada (Vancouver) 514 685 7530, China 86 21 6555 7838,
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00, Finland 385 0 9 725 725 11,
France 33 0 1 48 14 24 24, Germany 49 0 89 741 31 30, Greece 30 2 10 42 96 427, India 91 80 51190000,
Israel 972 0 3 6393737, Italy 39 02 413091, Japan 81 3 5472 2970, Korea 82 02 3451 3400,
Malaysia 603 9131 0918, Mexico 001 800 010 0793, Netherlands 31 0 348 433 466,
New Zealand 0800 553 322, Norway 47 0 66 90 76 60, Poland 48 22 3390150, Portugal 351 210 311 210,
Russia 7 095 783 68 51, Singapore 65 6226 5886, Slovenia 386 3 425 4200, South Africa 27 0 11 805 8197,
Spain 34 91 640 0085, Sweden 46 0 8 587 895 00, Switzerland 41 56 200 51 51, Taiwan 886 2 2528 7227,
Thailand 662 992 7519, United Kingdom 44 0 1635 523545

For further support information, refer to the *Technical Support and Professional Services* appendix. To comment on the documentation, send email to techpubs@ni.com.

Important Information

Warranty

The NI 5610 and NI 5421 hardware modules are warranted against defects in materials and workmanship for a period of one year from the date of shipment, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace equipment that proves to be defective during the warranty period. This warranty includes parts and labor.

The media on which you receive National Instruments software are warranted not to fail to execute programming instructions, due to defects in materials and workmanship, for a period of 90 days from date of shipment, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace software media that do not execute programming instructions if National Instruments receives notice of such defects during the warranty period. National Instruments does not warrant that the operation of the software shall be uninterrupted or error free.

A Return Material Authorization (RMA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. National Instruments will pay the shipping costs of returning to the owner parts which are covered by warranty.

National Instruments believes that the information in this document is accurate. The document has been carefully reviewed for technical accuracy. In the event that technical or typographical errors exist, National Instruments reserves the right to make changes to subsequent editions of this document without prior notice to holders of this edition. The reader should consult National Instruments if errors are suspected. In no event shall National Instruments be liable for any damages arising out of or related to this document or the information contained in it.

EXCEPT AS SPECIFIED HEREIN, NATIONAL INSTRUMENTS MAKES NO WARRANTIES, EXPRESS OR IMPLIED, AND SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER'S RIGHT TO RECOVER DAMAGES CAUSED BY FAULT OR NEGLIGENCE ON THE PART OF NATIONAL INSTRUMENTS SHALL BE LIMITED TO THE AMOUNT THERETOFORE PAID BY THE CUSTOMER. NATIONAL INSTRUMENTS WILL NOT BE LIABLE FOR DAMAGES RESULTING FROM LOSS OF DATA, PROFITS, USE OF PRODUCTS, OR INCIDENTAL OR CONSEQUENTIAL DAMAGES, EVEN IF ADVISED OF THE POSSIBILITY THEREOF. This limitation of the liability of National Instruments will apply regardless of the form of action, whether in contract or tort, including negligence. Any action against National Instruments must be brought within one year after the cause of action accrues. National Instruments shall not be liable for any delay in performance due to causes beyond its reasonable control. The warranty provided herein does not cover damages, defects, malfunctions, or service failures caused by owner's failure to follow the National Instruments installation, operation, or maintenance instructions; owner's modification of the product; owner's abuse, misuse, or negligent acts; and power failure or surges, fire, flood, accident, actions of third parties, or other events outside reasonable control.

Copyright

Trademarks

Patents

For patents covering National Instruments products, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your CD, or `ni.com/patents`.

WARNING REGARDING USE OF NATIONAL INSTRUMENTS PRODUCTS

(1) NATIONAL INSTRUMENTS PRODUCTS ARE NOT DESIGNED WITH COMPONENTS AND TESTING FOR A LEVEL OF RELIABILITY SUITABLE FOR USE IN OR IN CONNECTION WITH SURGICAL IMPLANTS OR AS CRITICAL COMPONENTS IN ANY LIFE SUPPORT SYSTEMS WHOSE FAILURE TO PERFORM CAN REASONABLY BE EXPECTED TO CAUSE SIGNIFICANT INJURY TO A HUMAN.

(2) IN ANY APPLICATION, INCLUDING THE ABOVE, RELIABILITY OF OPERATION OF THE SOFTWARE PRODUCTS CAN BE IMPAIRED BY ADVERSE FACTORS, INCLUDING BUT NOT LIMITED TO FLUCTUATIONS IN ELECTRICAL POWER SUPPLY, COMPUTER HARDWARE MALFUNCTIONS, COMPUTER OPERATING SYSTEM SOFTWARE FITNESS, FITNESS OF COMPILERS AND DEVELOPMENT SOFTWARE USED TO DEVELOP AN APPLICATION, INSTALLATION ERRORS, SOFTWARE AND HARDWARE COMPATIBILITY PROBLEMS, MALFUNCTIONS OR FAILURES OF ELECTRONIC MONITORING OR CONTROL DEVICES, TRANSIENT FAILURES OF ELECTRONIC SYSTEMS (HARDWARE AND/OR SOFTWARE), UNANTICIPATED USES OR MISUSES, OR ERRORS ON THE PART OF THE USER OR APPLICATIONS DESIGNER (ADVERSE FACTORS SUCH AS THESE ARE HEREAFTER COLLECTIVELY TERMED "SYSTEM FAILURES"). ANY APPLICATION WHERE A SYSTEM FAILURE WOULD CREATE A RISK OF HARM TO PROPERTY OR PERSONS (INCLUDING THE RISK OF BODILY INJURY AND DEATH) SHOULD NOT BE RELIANT SOLELY UPON ONE FORM OF ELECTRONIC SYSTEM DUE TO THE RISK OF SYSTEM FAILURE. TO AVOID DAMAGE, INJURY, OR DEATH, THE USER OR APPLICATION DESIGNER MUST TAKE REASONABLY PRUDENT STEPS TO PROTECT AGAINST SYSTEM FAILURES, INCLUDING BUT NOT LIMITED TO BACK-UP OR SHUT DOWN MECHANISMS. BECAUSE EACH END-USER SYSTEM IS CUSTOMIZED AND DIFFERS FROM NATIONAL INSTRUMENTS' TESTING PLATFORMS AND BECAUSE A USER OR APPLICATION DESIGNER MAY USE NATIONAL INSTRUMENTS PRODUCTS IN COMBINATION WITH OTHER PRODUCTS IN A MANNER NOT EVALUATED OR CONTEMPLATED BY NATIONAL INSTRUMENTS, THE USER OR APPLICATION DESIGNER IS ULTIMATELY RESPONSIBLE FOR VERIFYING AND VALIDATING THE SUITABILITY OF NATIONAL INSTRUMENTS PRODUCTS WHENEVER NATIONAL INSTRUMENTS PRODUCTS ARE INCORPORATED IN A SYSTEM OR APPLICATION, INCLUDING, WITHOUT LIMITATION, THE APPROPRIATE DESIGN, PROCESS AND SAFETY LEVEL OF SUCH SYSTEM OR APPLICATION.

Contents

About This Manual

Chapter 1
Getting Started with the NI 5670

Appendix A
Hardware Front Panel Connectors and Indicators

Appendix B
Troubleshooting

Appendix C
Technical Support and Professional Services

About This Manual

This guide explains how to install, configure, test, and begin using the NI 5670 RF Vector Signal Generator. Additional documents such as the *NI 5670 Help* (which includes the NI-RFSG instrument driver LabVIEW VI and LabWindows™/CVI™ function reference help), the *NI 5670 Hardware User Manual*, and *NI PXI-5670 Specifications* documents are accessible from **Start»Programs»National Instruments» NI-RFSG»Documentation**.

For free downloads of the most current versions of drivers, documentation, and example programs, refer to `ni.com/instruments`.

Conventions

The following conventions are used in this manual:

» The **»** symbol leads you through nested menus to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.

This icon denotes a tip, which alerts you to advisory information.

This icon denotes a note, which alerts you to important information.

This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.

bold Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

italic Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.

`monospace` Text in this font denotes text or characters that you enter from the keyboard. This font is also used for the proper names of paths, directories, programs, functions, operations, variables, and filenames.

Key Terms

AWG	Arbitrary Waveform Generator—refers to the NI 5421 arbitrary waveform generator hardware module.
module	Refers to one of the hardware components of the NI 5670: the NI 5421 arbitrary waveform generator or the NI 5610 wideband RF upconverter.
PLL	Phase-Locked Loop—an electronic circuit that controls an oscillator so that the circuit maintains a constant phase angle relative to a reference signal.
RF	Radio Frequency—refers to the signal output from the RF OUTPUT connector on the NI 5670 device front panel.
upconverter	A device that frequency-translates baseband signals to center around a specified RF frequency—refers to an NI 5610 2-slot RF upconverter hardware module.

1

Getting Started with the NI 5670

NI 5670 Overview

The NI PXI-5670 is a modular RF signal source consisting of two PXI hardware modules:

- NI PXI-5421—16 bit, 100 megasample-per-second (MS/s) arbitrary waveform generator (AWG) module (400 MS/s interpolated).
- NI PXI-5610—2.7 GHz RF superheterodyne upconverter module with input frequencies between 15 and 35 MHz.

The hardware modules interconnect using the included SMA-SMB coaxial cables as illustrated in the *Interconnecting NI 5670 Modules* section.

Note There is no single physical device labeled "NI PXI-5670." The NI 5670 is the instrument comprised of the two hardware modules (NI 5610 and NI 5421) and the NI-RFSG instrument driver.

The NI 5670 has the following characteristics and features:

- 250 kHz to 2.7 GHz frequency range
- 20 MHz real-time bandwidth
- 10 MHz oven-controlled crystal oscillator (OCXO) timebase
  - ±20 ppb frequency stability
  - ±50 ppb frequency accuracy
- 132 dB compression-to-noise dynamic range
- ≤–119 dBm/Hz typical noise density
- Up to 256 MB of onboard waveform memory
- NI-RFSG instrument driver software operates both modules as a single transparent unit.
- Three slots wide PXI/3U Compact PCI form factor

The NI 5670 follows industry-standard Plug and Play specifications for the PXI bus and can be seamlessly integrated with compliant systems.

NI 5610 Upconverter Module

The NI 5610, shown in Figure 1-1, is a 250 kHz to 2.7 GHz superheterodyne upconverter hardware module. It offers 20 MHz real-time bandwidth and a highly accurate oven-controlled crystal oscillator (OCXO) frequency reference that can be software-configured to drive the PXI 10 MHz backplane clock when the NI 5610 is installed in PXI Slot 2.

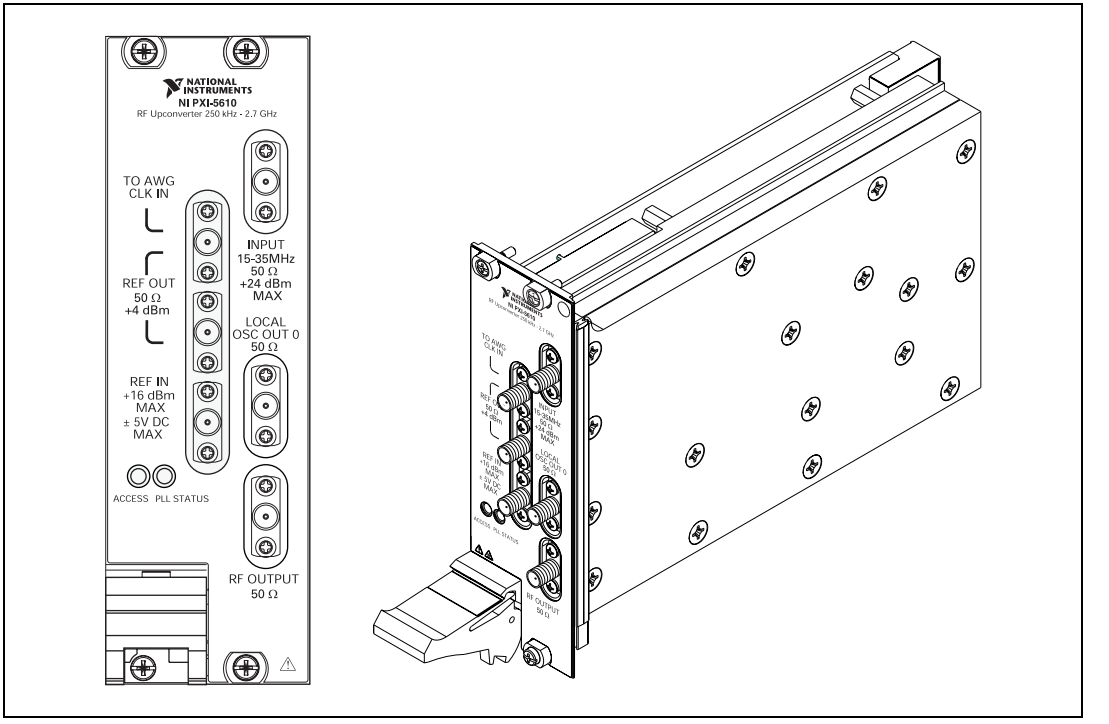


Figure 1-1. NI 5610 RF Upconverter Module

Tip The NI 5610 upconverter module (two slots wide) is installed in the leftmost of its two occupied PXI slots. Thus, installing the NI 5610 module in PXI Slot 2, for instance, occupies PXI Slots 2 and 3. Slot numbers are printed on the PXI chassis.

NI 5421 AWG Module

The NI 5421, shown in Figure 1-2, is a single-channel 16-bit 100 MS/s AWG hardware module.

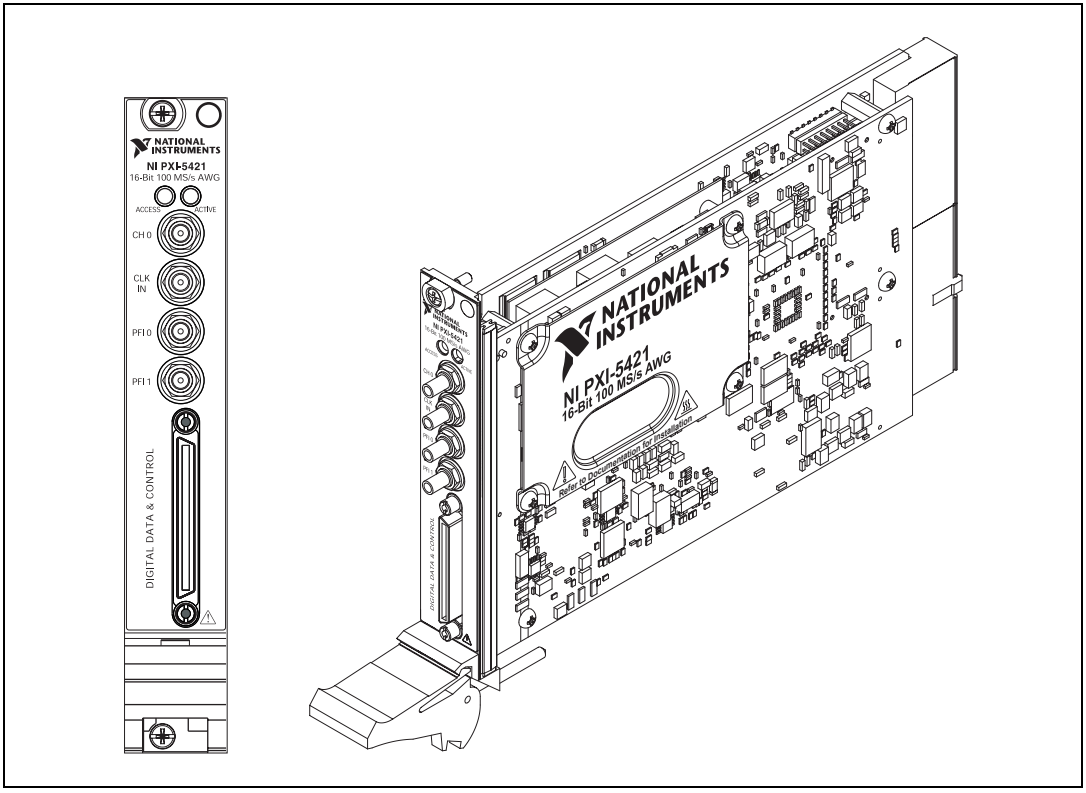


Figure 1-2. NI 5421 AWG Module

Verifying System Requirements

Minimal System

Before installing the NI 5670 hardware and software, verify that your PXI system meets the following requirements:

- Pentium IV or comparable processor
- Windows 2000/NT/XP
- 3 GB of free hard drive space
- 256 MB of RAM

Recommended System

For optimal performance with large waveforms, NI recommends that your PXI system meet the following requirements:

- Pentium IV or comparable processor
- Windows 2000/NT/XP
- 3 GB of free hard drive space
- 1 GB of RAM

Application Development Software

If you are developing applications, your system must include one of the following installed application development environments (ADEs) and associated documentation:

- NI LabVIEW 7.0 or later, Full Development System or Professional Development System
- LabWindows/CVI 6.0 or later

Note RAM requirements vary by application. Every 2^{20} samples of complex I-Q data require 8 MB of RAM. You may be able to substitute virtual memory for RAM depending on system speed and application needs.

Unpacking

Both hardware modules of the NI 5670 ship in antistatic packages to prevent damage from electrostatic discharge (ESD). Because ESD can damage several components of both NI 5670 hardware modules, store both modules in the antistatic envelopes when not in use.

Caution Never touch exposed connector pins.

To avoid damage in handling the NI 5670 hardware modules, take the following precautions:

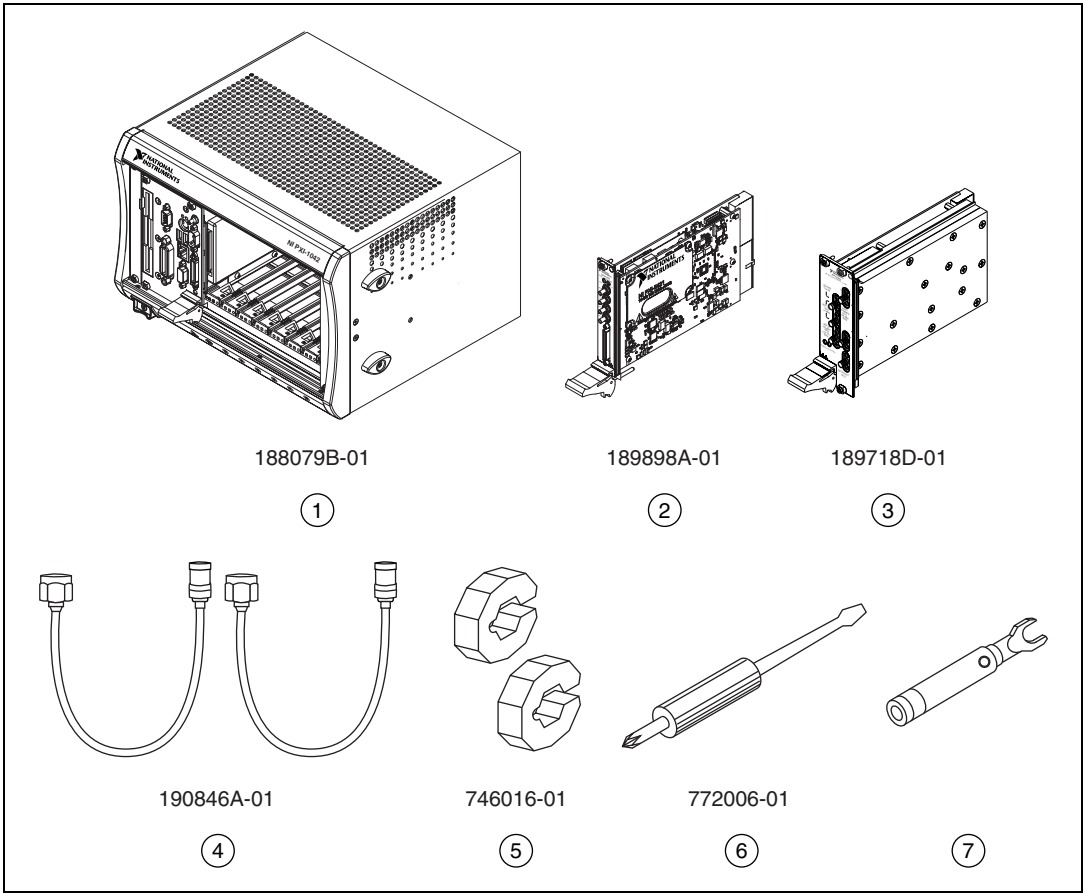
- Ground yourself using a grounding strap or by touching a grounded object.
- Touch the antistatic package to a metal part of your computer chassis before removing the hardware module from the package.

Remove each hardware module from the package and inspect it for loose components or any signs of damage. Notify NI if either hardware module appears damaged in any way. Do *not* install a damaged module into your system.

Verifying Kit Contents

In addition to this guide, you need the following items to set up and use the NI 5670 RF Vector Signal Generator:

- ❑ *NI-RFSG* CD—installs the following software components:
  - NI-RFSG instrument driver
  - NI-RFSG examples, intended for use as interactive applications, instructional models, or building blocks in your own applications
  - Hardware and software documentation
- ❑ The following hardware components, as shown in Figure 1-3.
  - Two hardware modules:
    - NI 5421 AWG module.
    - NI 5610 wideband upconverter module.
  - A PXI chassis with at least three empty slots (not included). NI recommends an NI PXI-1042 chassis.
  - A PXI embedded or MXI-3 controller system (not included) that meets the system requirements specified in this guide.
  - Two semi-flexible SMA-to-SMB coaxial cables.
  - 1/8-in. combination Phillips/flathead screwdriver.
  - Plastic collars (cable wrenches) for gripping the coaxial cable hex connectors.
  - A 100 N-cm standard SMA torque wrench (not included).



1	NI PXI-1042 Chassis (not included)	5	Cable Wrenches (2)
2	NI 5421 AWG Module	6	Screwdriver
3	NI 5610 Upconverter Module	7	100 N-cm SMA Torque Wrench (not included)
4	SMA-to-SMB Coaxial Cables (2)		

Figure 1-3. NI 5670 Required Parts Inventory and Replacement Part Numbers

Installing the Software

Complete the following steps to install the contents of the NI-RFSG CD:

1. Install a development environment such as NI LabVIEW and/or LabWindows/CVI according to its instructions. Any development environment you intend to use must be installed before you install the NI-RFSG CD.
2. Install the contents of the NI-RFSG software CD by navigating to your CD drive and clicking `setup.exe`.
3. Install any toolkits or other optional add-on software you intend to use with the NI 5670.

Note You must install the NI-RFSG CD before installing any add-on software you intend to use with the NI 5670. If add-on products are already installed, repeat or repair those installations after installing the NI-RFSG CD.

Installing the Hardware

PXI Slot Location

Installation of both NI 5670 hardware modules requires three vacant PXI slots—two slots for the NI 5610 upconverter module and one slot for the NI 5421 AWG module. The NI 5421 AWG module must be installed in the adjacent slot immediately to the right of the NI 5610 upconverter module to use the included SMA-to-SMB coaxial cables.

Note The NI 5670 specifications assume use of the included cables. Substituting different cables may affect performance.

The NI 5610 upconverter module onboard frequency reference can drive the PXI backplane clock *only* if the upconverter module is installed in PXI Slot 2. When the NI 5610 is installed in PXI Slot 2, you can configure it to lock the PXI backplane to the NI 5610 onboard oven-controlled crystal oscillator or to an external frequency source (connected to the REF IN connector on the NI 5610 module front panel).

Tip The NI 5610 upconverter module (two slots wide) is installed in the leftmost of its two occupied PXI slots. Thus installing the NI 5610 module in PXI Slot 2 occupies PXI Slots 2 and 3. Slot numbers are printed on the PXI chassis.

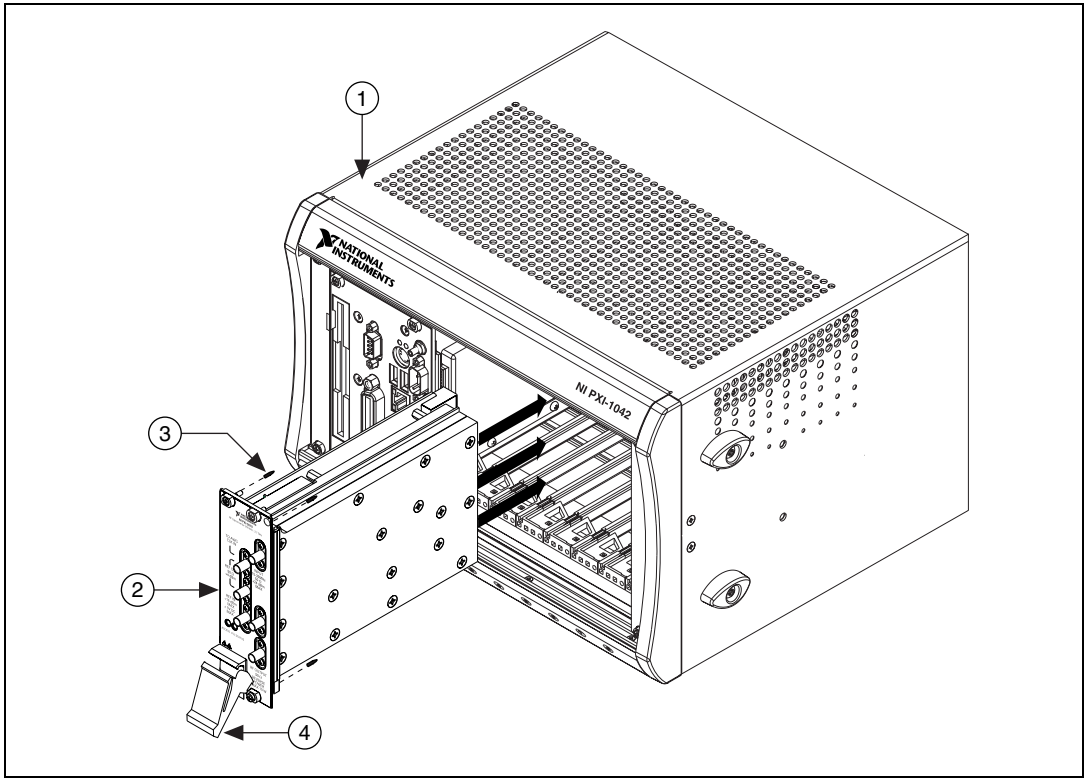
NI 5610 Upconverter Module Installation

Install the NI 5610 RF upconverter module by completing the following steps:

1. Power off your PXI chassis.
2. Install the NI 5610 upconverter module as shown in Figure 1-4. This module requires two vacant PXI slots.

Note The NI 5610 *must* be installed in PXI Slot 2 to optionally drive the PXI backplane with the NI 5610 onboard oven-controlled crystal oscillator or an external reference signal.

   a. Remove the black plastic protectors from the four captive screws in the module front panel.
   b. Slide the NI 5610 into an available PXI slot until the ejector handle locks in the upward position.
   c. Tighten the four screws in the module front panel.



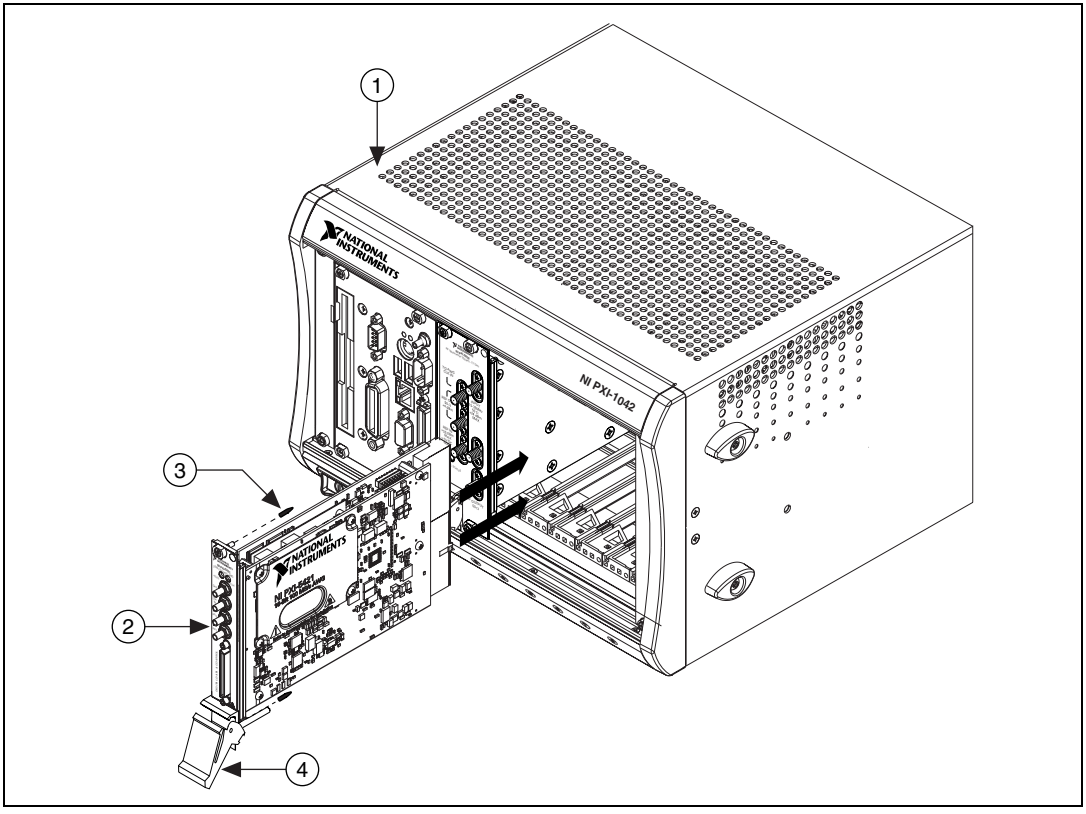
1 PXI Chassis	3 NI 5610 Upconverter Module
2 Remove Rubber Screw Covers	4 Ejector Handle in Down Position

Figure 1-4. Install the NI 5610 Upconverter Module

NI 5421 AWG Module Installation

Install the NI 5421 AWG module in the adjacent PXI slot immediately to the right of the NI 5610 upconverter module by completing the following steps:

1. Ensure that your PXI chassis is powered off.
2. Install the NI 5421 AWG module as shown in Figure 1-5.
   a. Remove the black plastic protectors from the two captive screws in the module front panel.
   b. Slide the NI 5421 into the slot immediately to the right of the NI 5610 upconverter module. Press firmly until the ejector handle locks in the upright position.
   c. Tighten both screws in the NI 5421 front panel.



1 PXI Chassis	3 Remove Rubber Screw Covers
2 NI 5421 AWG Module	4 Ejector Handle in Down Position

Figure 1-5. Install the NI 5421 AWG Module

3. Continue with the procedure in the *Interconnecting NI 5670 Modules* section once you have read and understood the *Cooling* section.

Cooling

Caution The NI 5610 front panel may become warm to the touch during normal operation, and caution should be used when removing and handling a recently used module.

The NI 5610 operates at internal temperatures of about 45 °C (113 °F) under conditions of proper air flow and 25 °C (63 °F) ambient temperatures.

Caution Inadequate air circulation could cause the temperature inside the chassis to rise above the optimal operating temperature for the NI 5670, potentially causing thermal shutdown, shorter lifespans, or improper performance.

Use the following guidelines to help maintain optimal forced-air cooling within the PXI chassis:

- Install all chassis covers and filler panels after installing your NI 5670 modules, as shown in Figure 1-6. Missing filler panels disrupt the necessary air circulation in the chassis.

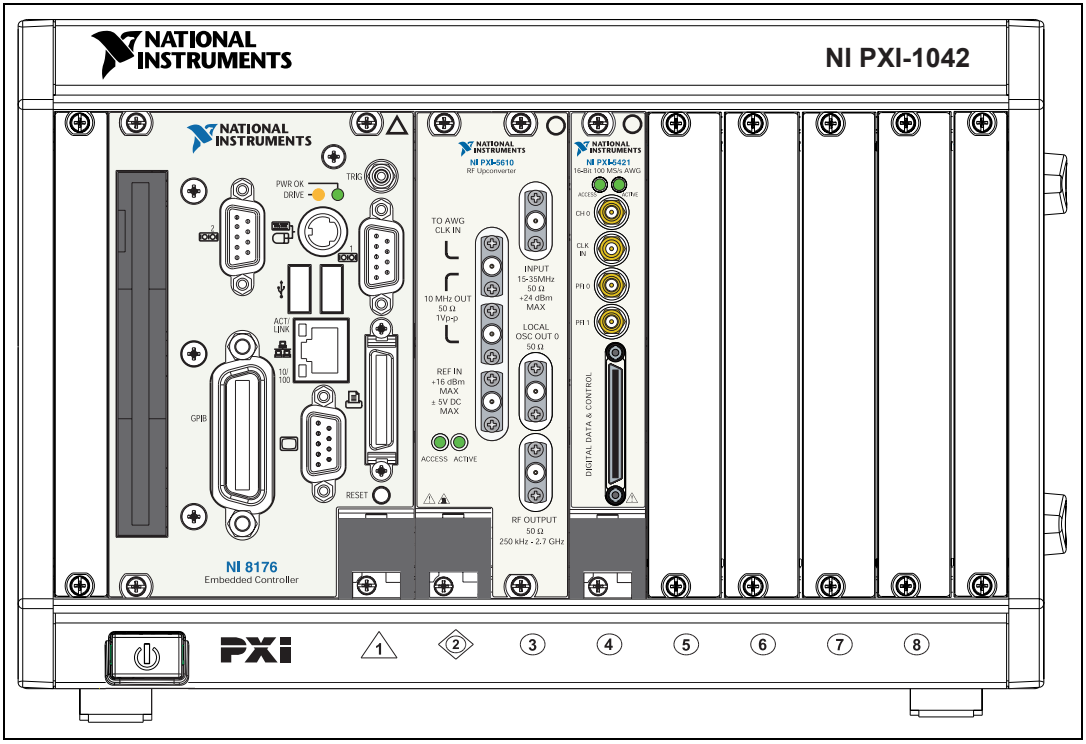
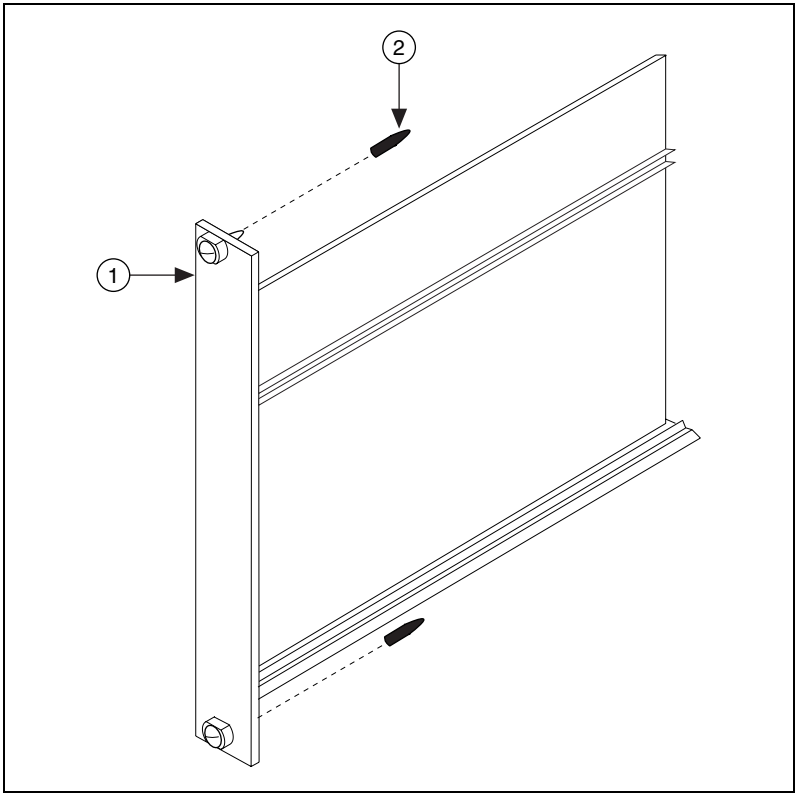


Figure 1-6. Install All PXI Filler Panels after Hardware Installation

- Allow plenty of space around the vents at the rear of the chassis. Blockage by walls or obstructions affects the air flow needed for cooling.
- Set all chassis fans to the highest possible setting. Do *not* set the fan speed to LOW or turn the fan off.
- Clean the fan filters on a regular basis to avoid fan and air circulation path blockage. Refer to your chassis documentation for cleaning procedures and other recommended maintenance.

- (Optional) NI recommends installing slot blockers to maximize cooling air flow. The PXI Chassis Slot Blocker Kit, part number 778678-01, is shown in Figure 1-7.



1 PXI Slot Blocker	2 Remove Rubber Screw Covers

Figure 1-7. Optional Slot Blockers Enhance Cooling

Overtemperature Shutdown

If the temperature of either module exceeds specifications, the instrument is disabled and the NI-RFSG driver software notifies you with a thermal shutdown error message.

To re-enable the NI 5670 after thermal shutdown, you must perform a device reset on each module in Measurement & Automation Explorer (MAX) or call the niRFSG Reset Device VI (`niRFSG_resetDevice` function) to reset both modules. Continue to the *Configuring the NI 5670 Modules in MAX* section for more information about using MAX.

Interconnecting NI 5670 Modules

The NI 5670 hardware modules interconnect through the front panels. Complete the following steps to interconnect the NI 5670 hardware module front panel connectors as shown in Figure 1-8.

1. Connect the INPUT connector on the NI 5610 upconverter module to the CH 0 connector on the NI 5421 AWG module.
2. Connect the TO AWG CLK IN connector on the NI 5610 upconverter module to the CLK IN connector on the NI 5421 AWG module.

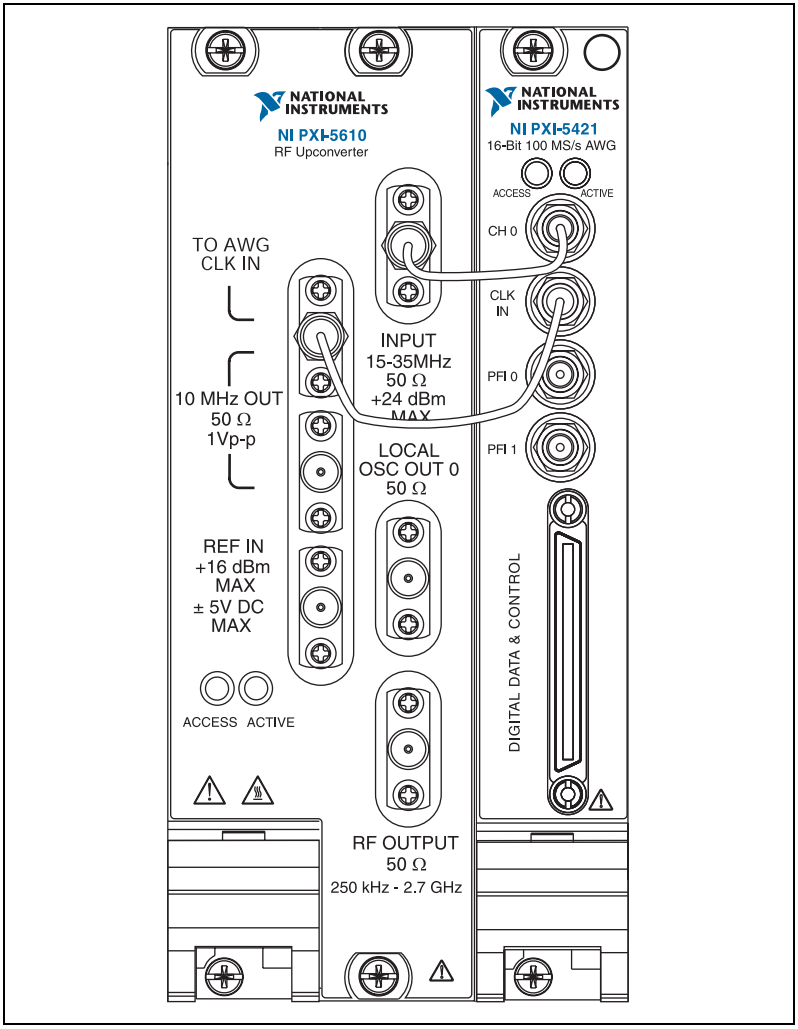


Figure 1-8. Proper Interconnection of the NI 5670 Front Panels

3. Carefully tighten all SMA connectors to 100 N-cm using an SMA torque wrench (not included) as shown in Figure 1-9. Tighten only until the wrench clicks.

Caution Incorrect torque at SMA connections can degrade signal fidelity, PLL performance, and insertion loss. Use an SMA torque wrench to ensure all SMA connections are properly torqued to 100 N-cm.

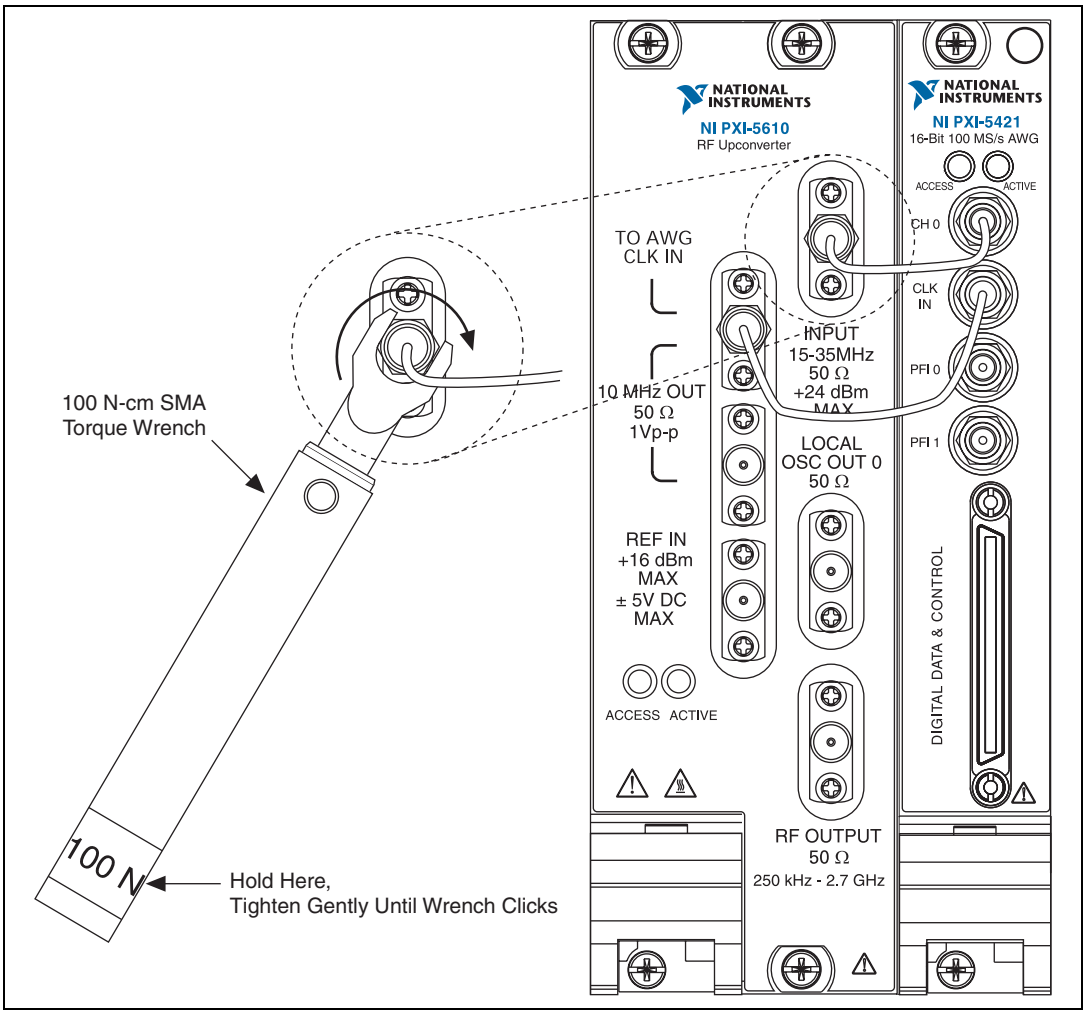


Figure 1-9. Torque All SMA Connectors to 100 N-cm

4. Power up your PXI chassis and controller system.
5. Verify that the ACCESS LED on both modules is illuminated. If the LEDs are not illuminated, refer to Appendix B, *Troubleshooting*.

Configuring the NI 5670 Modules in MAX

Measurement & Automation Explorer (MAX) is used to configure your National Instruments hardware. MAX informs other programs about which devices reside in the system and how they are configured. MAX is automatically installed with the NI-RFSG driver.

Note MAX treats the NI 5610 upconverter module and the NI 5421 AWG module as separate but associated devices. The MAX association is necessary for transparent operation of both modules as a single instrument (the NI 5670) using the NI-RFSG driver.

To use MAX to configure, self-test, associate, and generate signals with the NI 5670 hardware modules, complete the following steps:

1. Launch MAX by navigating to **Start»Programs» National Instruments»Measurement & Automation** or by clicking the MAX desktop icon.
2. In the Configuration pane, double-click **Devices and Interfaces** to see the list of installed devices.
3. Expand the **NI-DAQmx Devices** folder. You will see a list of installed devices that includes the NI 5610 and NI 5421 modules, as shown in Figure 1-10 (your default device names may vary).

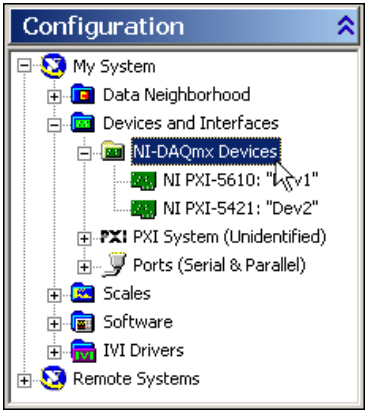


Figure 1-10. Both Modules Appear in MAX

Note If you do not see the NI PXI-5421 and NI PXI-5610 modules listed, refer to Appendix B, *Troubleshooting*.

Rename Both Modules

MAX allows you to rename both NI 5670 hardware modules with names of your choice. The name you specify in MAX is used in software to operate the NI 5670 hardware resources. You do not have to change your module names from the default, but doing so can make programming easier.

To rename both NI 5670 hardware modules, complete steps 4 through 10.

4. Right-click the NI 5610 upconverter module and select **Rename** from the shortcut menu as shown in Figure 1-11.

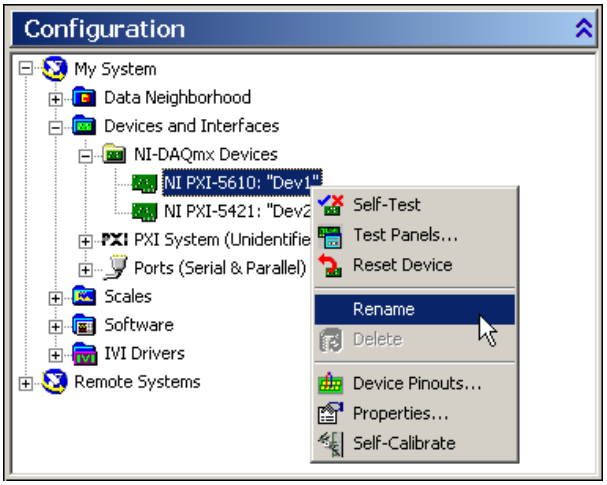


Figure 1-11. Rename the NI PXI-5610 Upconverter Module

5. Type the new name for the NI 5610 upconverter module.
6. Click **OK**.

Note The device name cannot duplicate a module type. For example, MAX cannot rename a module as `NI PXI-5610`. Choose descriptive names such as `Upconverter` or `AWG` instead.

7. Right-click the NI 5421 AWG module and select **Rename** from the shortcut menu as shown in Figure 1-12.

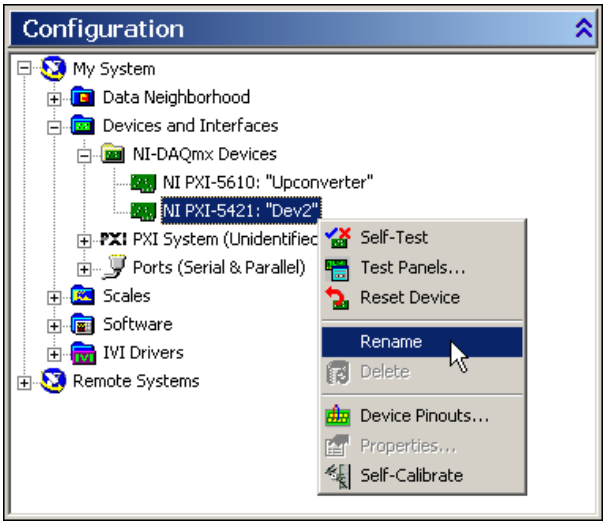


Figure 1-12. Rename the NI PXI-5421 AWG Module

8. Type the new name for the NI 5421 AWG module. The new device name cannot begin with `NI PXI-`.
9. Click **OK**.
10. Verify that the new names for both modules are displayed as the example in Figure 1-13 shows before proceeding to step 11.

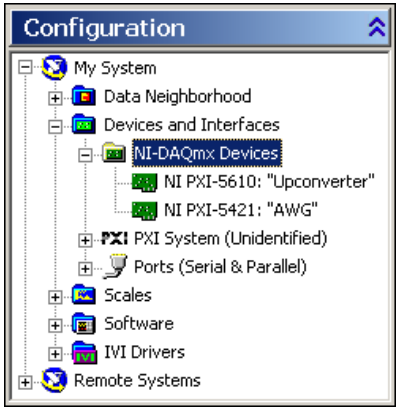


Figure 1-13. Renamed NI 5670 Hardware Modules

Self-Test Both Modules

The MAX self-test performs a basic verification of hardware resources. Complete steps 11 through 14 to self-test both modules.

11. Right-click the NI PXI-5610 and select **Self-Test**, as shown in Figure 1-14.

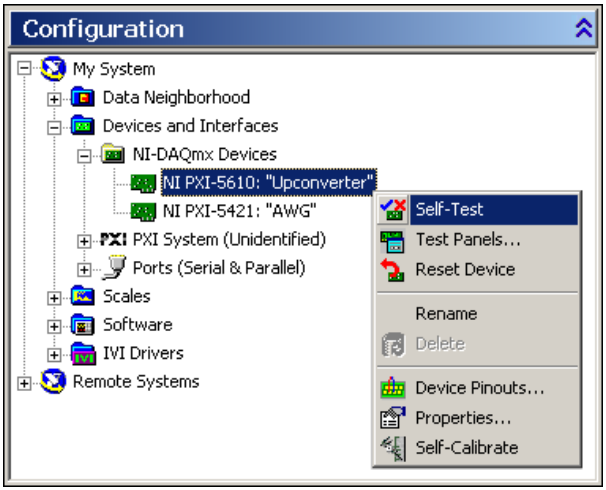


Figure 1-14. Select Self-Test from the NI PXI-5610 Right-Click Menu

12. The Success dialog appears as shown in Figure 1-15. Click **OK** to return to MAX.

Figure 1-15. Self-Test Result for the NI 5610 Upconverter Module

Note If the NI 5610 upconverter module fails the self-test, refer to Appendix B, *Troubleshooting*.

13. Right-click **NI PXI-5421** and select **Self-Test**, as shown in Figure 1-16.

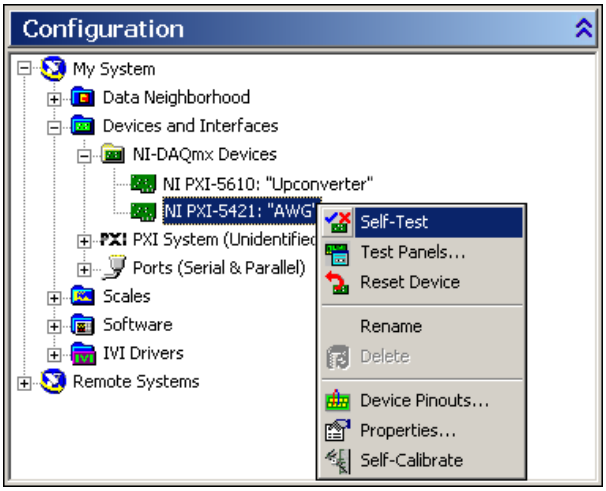


Figure 1-16. Select Self-Test from the NI PXI-5421 Right-Click Menu

14. The **Success** dialog appears as shown in Figure 1-17. Click **OK** to return to MAX.

Figure 1-17. Self-Test Result for the NI 5421 AWG Module

Note If the NI 5421 AWG module fails the self-test, refer to Appendix B, *Troubleshooting*.

Associate an NI 5421 AWG Module

You must create a MAX association between the NI 5610 and the NI 5421 to control both hardware modules as a single instrument. Complete steps 15 through 17 to make this association.

15. Right-click **NI PXI-5610** and select **Properties** as shown in Figure 1-18.

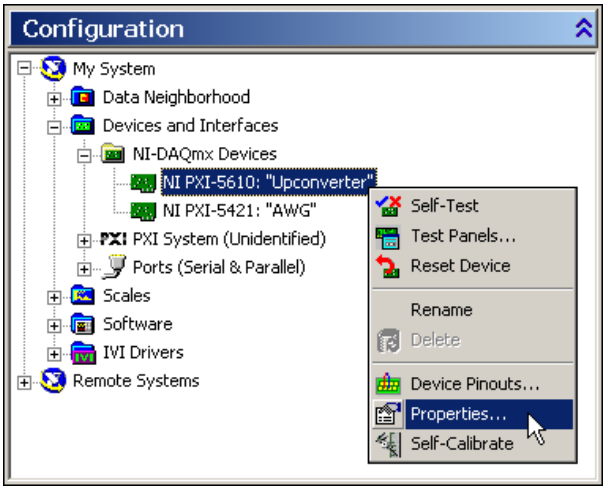


Figure 1-18. Select Properties from the NI PXI-5610 Right-Click Menu

16. In the NI 5610 Device Properties dialog (Figure 1-19), use the drop-down listbox to specify the NI 5421 AWG module that is connected to the NI 5610 by front panel coaxial cables. Refer to the *Interconnecting NI 5670 Modules* section for more information.

Tip You must repeat this association if you rename the NI 5421 AWG module after association. Remember to reassociate the NI 5670 hardware modules if you rename the NI 5421 AWG module.

Figure 1-19. Associate an AWG in the NI 5610 Device Properties Dialog

17. Click **OK** to return to MAX.

Run the NI 5670 Test Panel

The NI 5670 test panel tests both hardware modules as a single instrument. Complete steps 18 through 24 to use the NI 5670 test panel.

Note This test requires front panel interconnection as shown in Figure 1-8 and the association of an NI 5421 AWG module with an NI 5610 upconverter module as described in steps 15 through 17.

18. Right-click the NI PXI-5610 upconverter module and select **Test Panels** as shown in Figure 1-20.

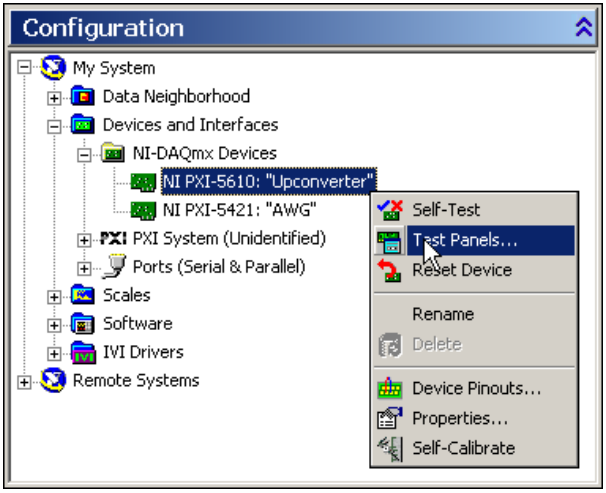


Figure 1-20. Right-Click NI PXI-5610 to Open the NI 5670 Test Panel

19. In the **NI PXI-5670** tab of the Test Panels dialog, specify a frequency and a power level for signal generation as shown in Figure 1-21.

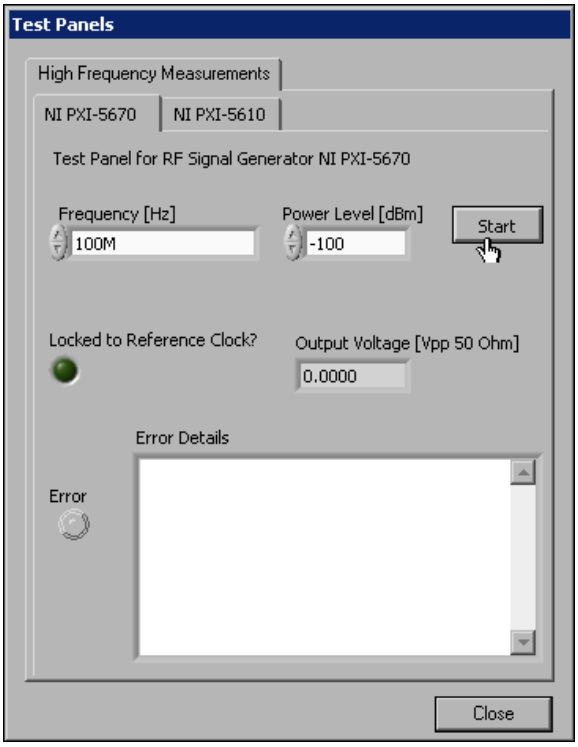


Figure 1-21. The NI PXI-5670 RF Vector Signal Generator Test Panel

20. This panel verifies that the NI 5670 is locking to the reference clock and generating a signal. Click **Start** to begin signal generation.

Tip Running the test panel outputs a signal from the RF OUTPUT front panel connector. Disconnect any equipment that may be damaged by the test signal.

21. During signal generation the ACTIVE LEDs on both NI 5670 hardware modules are activated and the test panel is displayed as shown in Figure 1-22.

Note If either ACTIVE LED does not illuminate or if the NI 5670 test panel generates an error, refer to Appendix B, *Troubleshooting*.

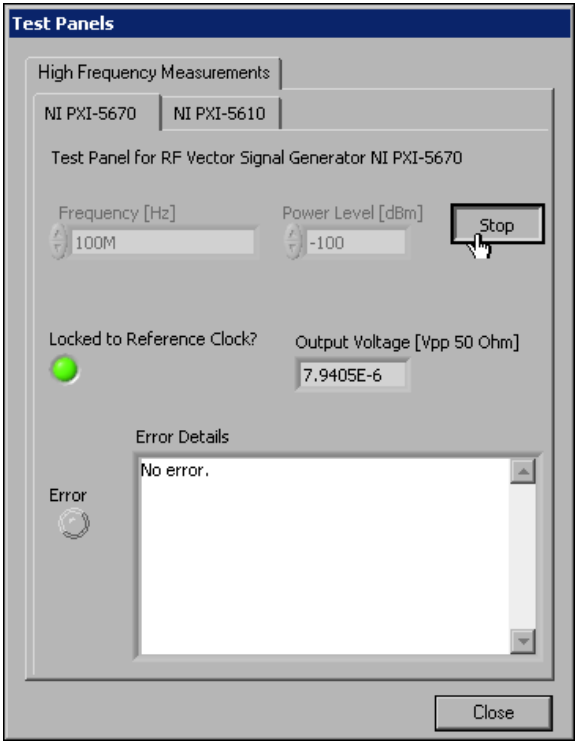


Figure 1-22. The NI PXI-5670 Test Panel during Signal Generation

22. Click **Stop** to halt waveform generation.
23. Click **Close** to return to MAX.
24. Exit MAX.

You have completed setup, configuration, and testing of the NI 5670 RF Vector Signal Generator.

Introduction to the NI-RFSG Driver

The NI-RFSG instrument driver software controls all NI 5670 configuration and operation using LabVIEW VIs or LabWindows/CVI functions. The NI-RFSG instrument driver transparently operates the NI 5610 upconverter module and the NI 5421 AWG module as a single instrument (the NI 5670). The modules are associated as a single instrument in MAX (refer to the *Configuring the NI 5670 Modules in MAX* section for more information).

The NI-RFSG driver configures and operates the NI 5670 hardware, performs waveform programming and generation, and is capable of basic IQ modulation tasks. Optional add-on software available from NI, including the Modulation Toolkit and the Spectral Measurements Toolkit, extends the capability of the NI 5670 to include additional frequency-domain and modulation-domain tasks.

The simple hardware/software hierarchy of the NI 5670 is shown in Figure 1-23.

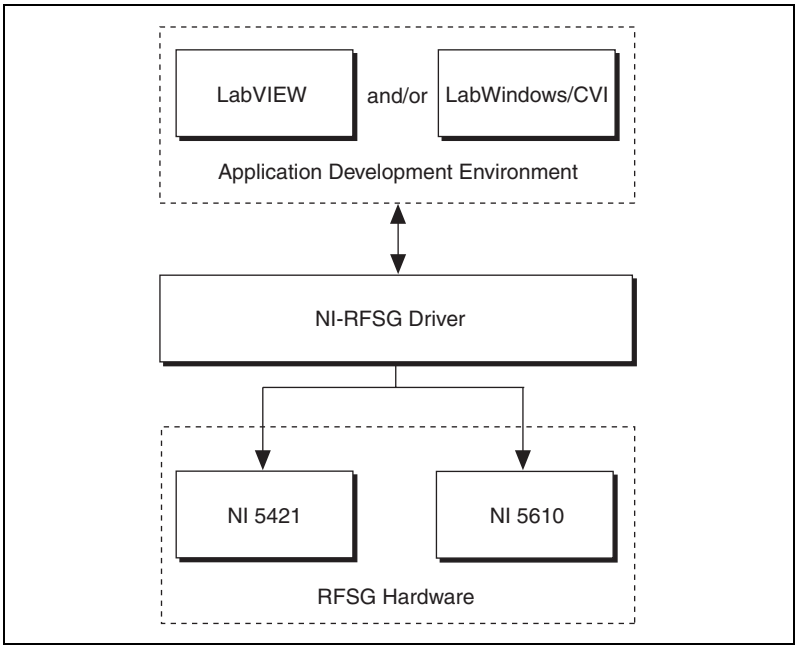


Figure 1-23. NI-RFSG Programming Flow

Note Refer to the *NI 5670 Help* or the *NI 5670 Hardware User Manual* for a more hardware/software hierarchy diagram. Both documents are installed at **Start»Programs» National Instruments»NI-RFSG»Documentation**.

NI-RFSG Programming Flow

NI-RFSG VIs are located on the LabVIEW function palette at **Instrument I/O»Instrument Drivers»NI-RFSG**. The top-level NI-RFSG functions palette is shown in Figure 1-24.

Tip Refer to the interactive version of this walkthrough in the *NI-5670 Help* for more information and for help finding NI-RFSG VIs on the LabVIEW palette. The *NI 5670 Help* is installed at **Start»Programs»National Instruments»NI-RFSG»Documentation**.

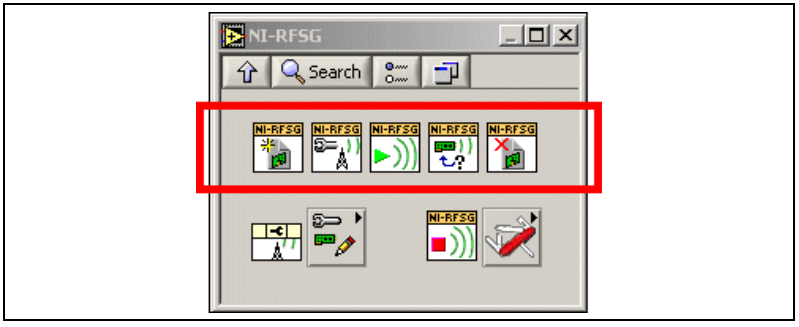


Figure 1-24. NI-RFSG LabVIEW Palette. Core VIs are Highlighted.

Note Every application using NI-RFSG must call the five VIs highlighted in the palette image above.

These VIs are arranged from left to right in the order they must be called:

1. 	**niRFSG Initialize**—Opens a session to the NI 5670 hardware modules and initializes both the NI 5421 AWG and the NI 5610 upconverter modules.
2. 	**niRFSG Configure RF**—Configures the frequency and power level of the RF output signal.
3. 	**niRFSG Initiate**—Initiates signal generation. After calling this function, the RF output signal is settled.
4. 	**niRFSG Check Generation Status**—Monitors signal generation status and verifies correct hardware and software operation during signal generation.
5. 	**niRFSG Close**—Closes the niRFSG session, and deallocates memory resources used by NI-RFSG. You must call this VI once for every NI-RFSG session opened with niRFSG Initialize.

NI-RFSG Example Applications

NI-RFSG includes several example applications for both LabVIEW and LabWindows/CVI. These examples are intended to serve as interactive tools, programming models, and building blocks in your own applications.

With LabVIEW running, select **Help»Find Examples** to launch the LabVIEW Example Finder. The Example Finder offers two ways to access all installed LabVIEW example VIs and their descriptions:

- Click the **Browse** tab to locate NI-RFSG examples by task at **Hardware Input and Output»Modular Instruments» NI-RFSG** or by directory structure at **instr»niRFSG**.
- Click the **Search** tab to search all installed examples by keyword. Enter the keyword `FM`, for instance, to locate an example demonstrating FM signal generation using the NI 5670 and the NI Modulation Toolkit (if installed).

LabVIEW and LabWindows/CVI users also can access all the installed NI-RFSG examples at **Start»Programs»National Instruments» NI-RFSG»Examples**. View LabVIEW examples by navigating to the `<LabVIEW home>\examples\instr\niRFSG` folder. View examples for CVI by navigating to the `<Program Files>\IVI\Drivers\niRFSG\Examples\CVI` directory.

Examples also are available online at `ni.com/examples` that demonstrate integrating the NI 5670 RF Signal Generator with the NI 5660 RF Signal Analyzer and NI toolkit software including the Modulation Toolkit. Refer to the NI Developer Zone on the Web at `ni.com/examples` for these examples and more information.

Building a Basic NI-RFSG Application

Complete the following steps in LabVIEW to build a basic NI-RFSG application for generating continuous sine wave signals:

1. Select **Start»Programs»National Instruments»LabVIEW 7» LabVIEW** to launch LabVIEW. The LabVIEW dialog appears.
2. Click **New**, choose **Blank VI**, and click **OK** to create a blank VI.
3. Display the block diagram by clicking it or by selecting **Window»Show Block Diagram**.
4. Activate the LabVIEW context help by pressing <Ctrl-H>.
5. Navigate to the NI-RFSG VIs on the **Functions»Instrument I/O» Instrument Drivers»NI-RFSG** palette.
6. Create the block diagram shown in Figure 1-25 by wiring the five core VIs on the block diagram in the order they appear in the top row of the NI-RFSG functions palette.

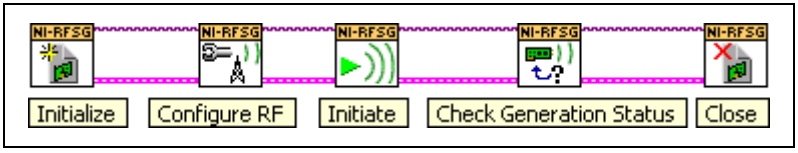


Figure 1-25. Basic NI-RFSG Block Diagram

7. Hover the cursor over the **resource name** terminal on the niRFSG Initialize VI and right-click. Select **Create»Control** to create a front panel field where you specify the NI 5670 device name. The **resource name** terminal is highlighted in Figure 1-26.

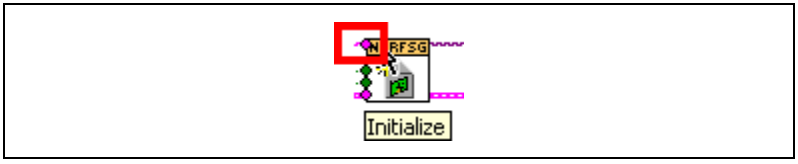


Figure 1-26. Resource Name Terminal on niRFSG Initialize VI

8. Hover the mouse tool over the **frequency (Hz)** and **power level (dBm)** terminals of the niRFSG Configure RF VI. These terminals are highlighted in Figure 1-27.

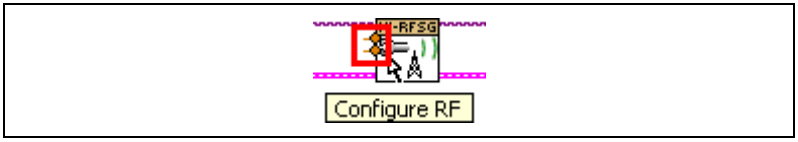


Figure 1-27. Frequency and Power Level Terminals on the niRFSG Configure RF VI

9. Right-click each terminal and select **Create»Control** from the shortcut menu to create frequency and power controls as shown in Figure 1-28.

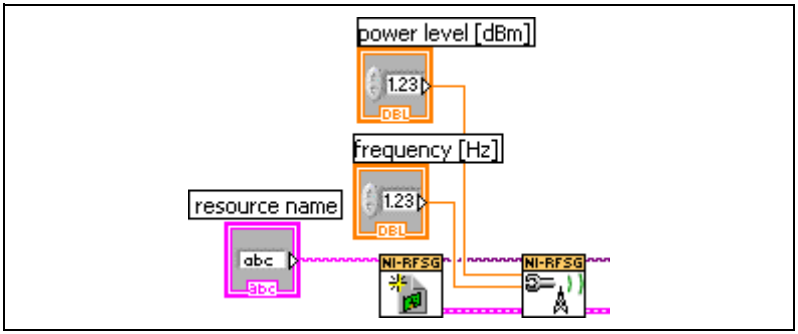


Figure 1-28. Frequency and Power Level Controls on the Block Diagram

10. Display the VI front panel by clicking it or by selecting **Window» Show Front Panel**. Fields are displayed in which you can specify a frequency and power level.
11. In the VI front panel **power level (dBm)** field, type `0`. In the **frequency (Hz)** field, type `100M` (100 MHz).
12. In the VI front panel **resource name** field, type the NI 5610 upconverter module name that you specified in MAX. The NI 5610 upconverter module must be associated with a NI 5421 AWG module. Refer to the *Configuring the NI 5670 Modules in MAX* section for more information.

Continous waveform generation is controlled by means of a STOP button. A STOP button is typically used within a While Loop. This example places a While Loop around the Check Generation Status VI so that signal generation continues and waveform status is continuously checked until you click STOP.

Build a STOP button by completing steps 13 through 17.

13. Display the block diagram by clicking it or selecting **Window» Show Block Diagram**.
14. Select the While Loop on the **All Functions»Structures** palette.
15. Enclose the niRFSG Check Generation Status VI in the While Loop, as shown in Figure 1-29.

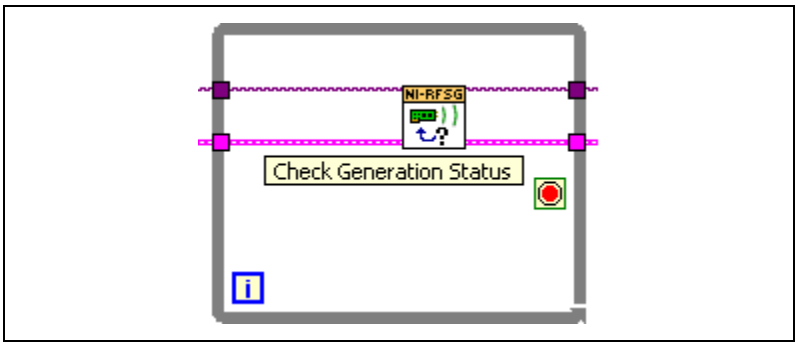


Figure 1-29. Enclose niRFSG Check Generation Status VI in the While Loop

16. Hover the mouse tool over the **Loop Condition** terminal of the While Loop. The terminal is highlighted in Figure 1-30.

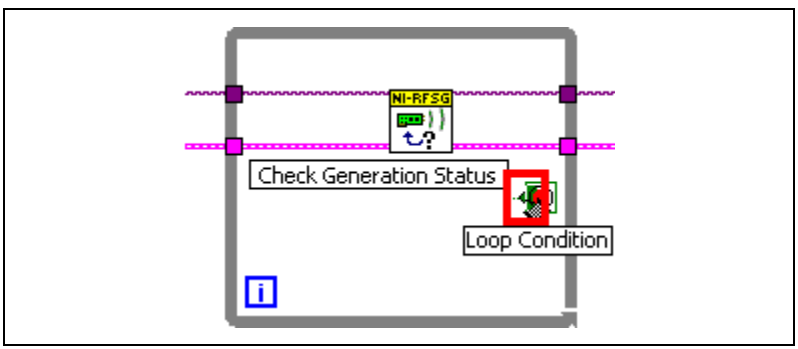


Figure 1-30. Loop Condition Terminal on While Loop

17. Right-click the **Loop Condition** terminal and select **Create Control** from the shortcut menu to create a STOP button on the VI front panel. The resulting portion of the block diagram is shown in Figure 1-31.

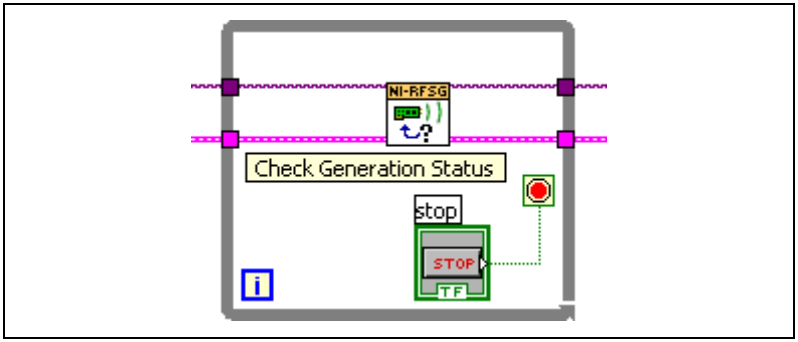


Figure 1-31. While Loop with STOP Button

Complete steps 18 through 19 to add an error indicator to your VI front panel:

18. Create an error indicator by right-clicking the **error out** terminal of the niRFSG Close VI and selecting **Create»Indicator**. The **error out** terminal is highlighted in Figure 1-32.

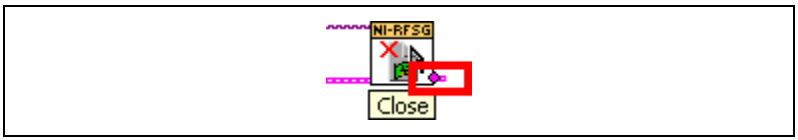


Figure 1-32. Error Out Terminal on niRFSG Close VI

19. Verify that your VI block diagram now looks like the example in Figure 1-33.

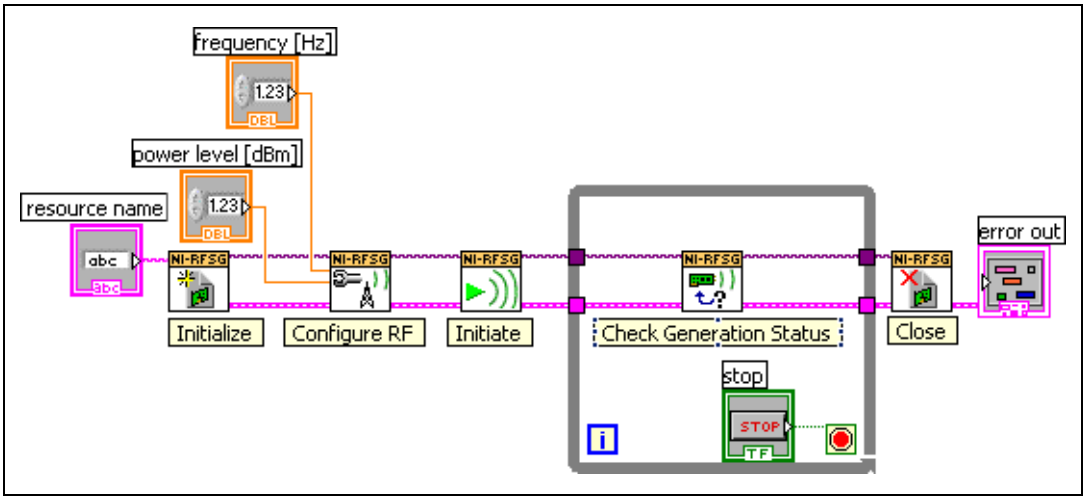


Figure 1-33. Basic Sine Wave Generation VI Block Diagram

20. Display the VI front panel by clicking it or by selecting **Window» Show Front Panel**. Verify that your VI front panel looks like the example in Figure 1-34.

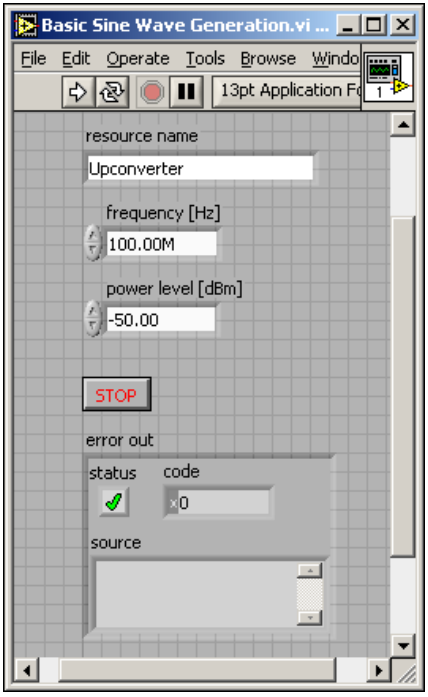


Figure 1-34. Basic Sine Wave Generation VI Front Panel

Note The **resource name** control is populated with the NI 5610 upconverter module name specified in MAX; refer to the *Rename Both Modules* section for more information.

21. Click the **RUN** icon on the VI taskbar to initiate sine wave generation.
22. Click the VI front panel **STOP** button to stop sine wave generation.

Caution Always stop VI operation using the front panel STOP button you created.

Never stop a VI with the ABORT button on the taskbar. The ABORT button does not free memory resources and leaves hardware and software in an unknown state.

You have successfully generated a continuous sine wave signal using the NI-RFSG driver software and the NI 5670 hardware.

Help for Other Tasks

With LabVIEW running, select *NI 5670 Help* from the **Help** pull-down menu. The *NI 5670 Help* contains hardware and software reference information and instructions for performing common RF signal generation tasks.

You also can access the *NI 5670 Help* from **Start»Programs» National Instruments»NI-RFSG»Documentation**.

A

Hardware Front Panel Connectors and Indicators

These sections describe the connectors and LED indicators on the front panels of both NI 5670 hardware modules. All inputs and outputs are AC-coupled.

NI 5610 Upconverter Module

The NI 5610 upconverter module front panel contains six connectors and two multicolor LEDs, as shown in Figure A-1.

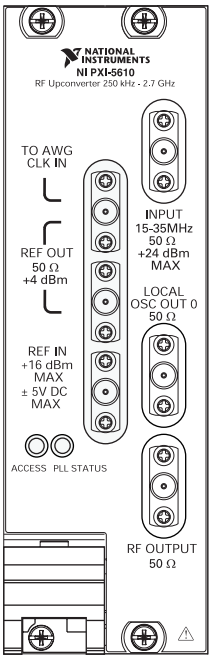


Figure A-1. NI 5610 Upconverter Module Front Panel

Table A-1. NI 5610 RF Upconverter Module Front Panel Connectors

Connector	Use
10 MHz OUT (TO AWG CLK IN)	Connect the TO AWG CLK IN connector to the CLK IN connector on the NI 5421 module front panel.
10 MHz OUT	Both connectors output replications of the upconverter 10 MHz frequency reference signal, useful for driving other devices. Each replication is 180 degrees out-of-phase with the other. The signal output at these connectors is always on and cannot be disabled.
REF IN	Routes an external frequency reference signal that can be propagated to the PXI backplane. The NI 5610 can lock to this signal.
IF INPUT	Connect to the CH 0 output on the NI 5421 front panel. Routes the IF signal from the NI 5421 AWG module for frequency translation.
LOCAL OSC OUT 0	Outputs the auxiliary local oscillator signal.
RF OUTPUT	Outputs the upconverted signal at the requested RF frequency.

Table A-2. NI 5610 RF Upconverter Module Front Panel LEDs

LED	Indications
ACCESS	Indicates the basic hardware status of the NI 5610 module. This LED functions identically to the ACCESS LED on the AWG module front panel. OFF—The module is not yet functional, or has detected a problem with a PXI power rail. AMBER—The module is being accessed. GREEN—The module is ready to be programmed.
ACTIVE	Indicates the status of the NI 5610 PLLs. OFF—The module is in an uninitialized state; there is no error. AMBER—The module PLLs are attempting to lock. GREEN—The module is in a ready state; applicable PLLs are locked and the reverse power protection circuit is closed. RED—The module has detected an error state; this may indicate an overload (reverse power protection circuit is open), lock failure in an applicable PLL, a self-test or calibration failure, or a thermal shutdown condition.

NI 5421 AWG Module

The front panel of the NI 5421 AWG module contains five connectors and two multicolor LEDs, as shown in Figure A-2.

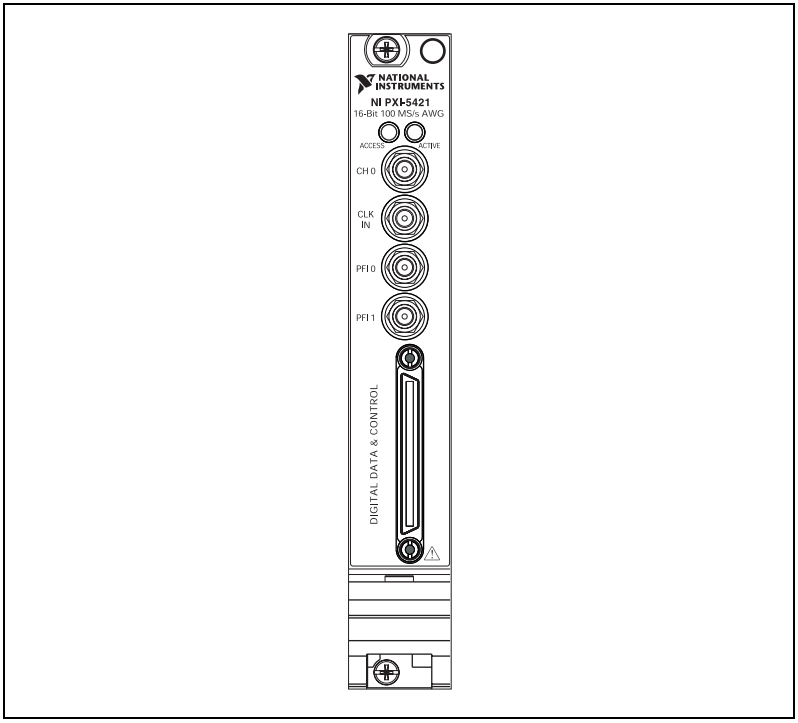


Figure A-2. NI 5421 AWG Module Front Panel

Table A-3. NI 5421 AWG Module Front Panel Connectors

Connector	Use
CH 0	Outputs an IF waveform for upconversion to the desired RF frequency. Connect to the IF INPUT connector on the NI 5610 front panel.
CLK IN	Inputs the NI 5421 internal reference clock signal. Connect to the REF OUT connector on the NI 5610 module front panel.
PFI 0	Bidirectional SMB connectors. As an input, the PFI terminals can accept a trigger from an external source to start or step through signal generation.
PFI 1	

Table A-4. NI 5421 AWG Module Front Panel LEDs

LED	Indications
ACCESS	Indicates the basic hardware status of the NI 5421 AWG module. This LED functions identically to the ACCESS LED on the NI 5610 upconverter module front panel. OFF—The module is not yet functional, or has detected a problem with a power rail. AMBER—The module is being accessed. GREEN—The module is ready to be programmed.
ACTIVE	Indicates the state of the NI 5421 AWG module. OFF—The module is not armed or triggered. AMBER—The module is armed and waiting for a Start trigger. GREEN—The module has received a Start trigger and is generating a waveform. RED—The module has detected an error state; this may indicate PLL unlocking, self-test failure, or calibration failure.

B

Troubleshooting

This section discusses issues you may encounter during installation of the NI 5670 RF Vector Signal Generator hardware and software. You also can refer to the *Troubleshooting* section of the *NI 5670 Hardware User Manual*, accessible from **Start»Programs»National Instruments» NI-RFSG»Documentation**.

Module Front Panel ACCESS LED is Off When PXI Chassis is On

If the ACCESS LED fails to light, a problem may exist with the PXI power rail, a hardware module, or the LED. Complete the following steps to troubleshoot this issue:

1. Power off your PXI chassis.
2. Remove any module front panel interconnections between the NI 5670 modules.
3. Remove the NI 5670 hardware modules and inspect for damage. Do *not* reinstall a damaged device.
4. Reinstall both NI 5670 hardware modules in different PXI slots. Use the procedure detailed in the *Installing the Hardware* section of Chapter 1, *Getting Started with the NI 5670*.
5. Power on your PXI chassis.
6. If either ACCESS LED still fails to light, and failures continue, contact NI technical support at `ni.com/ask` or call 866-275-6964 and ask to speak to a customer service representative.

Hardware Module Does Not Appear in MAX

Use the following procedure if either NI 5670 hardware module does not appear in MAX:

1. In the MAX Configuration pane, click the **NI-DAQmx Devices** folder and press <F5> to refresh the list of installed devices.
2. If either module is still not listed, power off the system, ensure the NI 5670 hardware is correctly installed, and restart the system.
3. Open the Windows Control Panel and select **System»Hardware» Device Manager**. Complete the appropriate step for your setup:
   - If using a PXI controller, verify that a **National Instruments** entry appears in the system device list. Reinstall NI-RFSG and the NI 5670 hardware modules if error conditions are present in the list.
   - If using a MXI-3 controller, right-click **PCI-to-PCI Bridge** and select **Properties** from the shortcut menu to verify that the bridge is enabled.
4. If either module still fails to appear in the MAX **NI-DAQmx Devices** folder, contact NI technical support at `ni.com/ask` or call 866-275-6964 and ask to speak to a customer service representative.

A Module Fails the Self-Test

The MAX self-test performs a brief test of device resources. If either module of the NI 5670 hardware does not pass the self-test, complete the following steps:

1. Reboot your system.
2. Launch MAX and perform the self-test again. If the module still fails the self-test, proceed to step three.
3. Uninstall the NI-RFSG driver software using the Add/Remove Programs option on the Windows Control Panel. Never attempt to uninstall by deleting files.
4. Reinstall NI-RFSG by running `setup.exe` on the NI-RFSG CD.
5. If either module still fails the self-test, contact NI technical support at `ni.com/ask` or call 866-275-6964 and ask to speak to a customer service representative.

The NI 5670 Test Panel Fails

The NI 5670 test panel tests both hardware modules as a single instrument. If the test panel fails or generates an error, complete the following steps to locate the problem:

1. Verify that both NI 5670 modules are interconnected through the module front panels as shown in Figure 1-8, *Proper Interconnection of the NI 5670 Front Panels*, of Chapter 1, *Getting Started with the NI 5670*.
2. Ensure that all front panel connections are secure. All SMA connections should be tightened to 100 N-cm using a standard SMA torque wrench. Loose connections can impair instrument operation.

3. Launch MAX by navigating to **Start»Programs» National Instruments»Measurement & Automation** or by clicking the MAX desktop icon, shown at left.
4. Navigate to the **Device and Interfaces»NI-DAQmx Devices** folder.
5. Right-click **NI PXI-5610** and select **Properties**, as shown in Figure B-1.

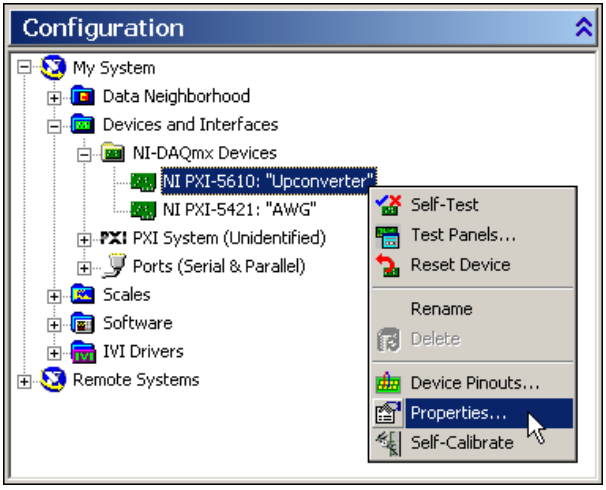


Figure B-1. Select Properties from the NI PXI-5610 Right-Click Menu

6. In the NI 5610 Device Properties dialog, verify that the proper NI 5421 AWG module (that is, the one interconnected to the NI 5610 upconverter module) is associated as shown in Figure B-2.

Figure B-2. The NI PXI-5610 Device Properties Dialog Displays the Associated AWG

7. If this panel does not show an NI 5421 AWG module associated with the NI 5610, right-click the drop-down listbox to select an available NI 5421 AWG module to associate as shown in the *Configuring the NI 5670 Modules in MAX* section of Chapter 1, *Getting Started with the NI 5670*.
8. When the correct NI 5421 AWG module is specified, click **OK** to return to MAX.

9. In the MAX Configuration tree, right-click **NI PXI-5610** and select **Test Panels** as shown in Figure B-3.

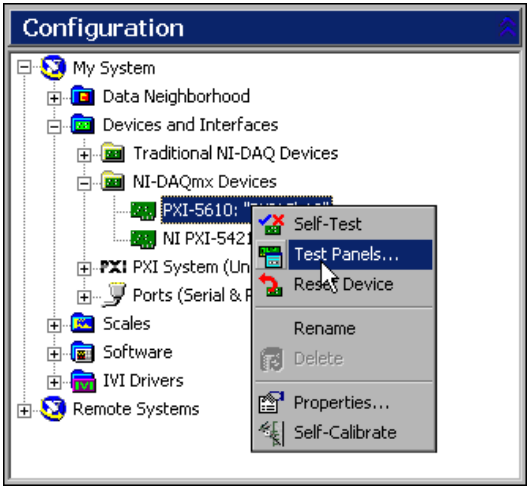


Figure B-3. Open the NI 5670 Test Panel from the NI PXI-5610 Right-Click Menu

10. In the **Test Panels** window, click the **NI PXI-5610** tab to view the NI 5610 test panel shown in Figure B-4.

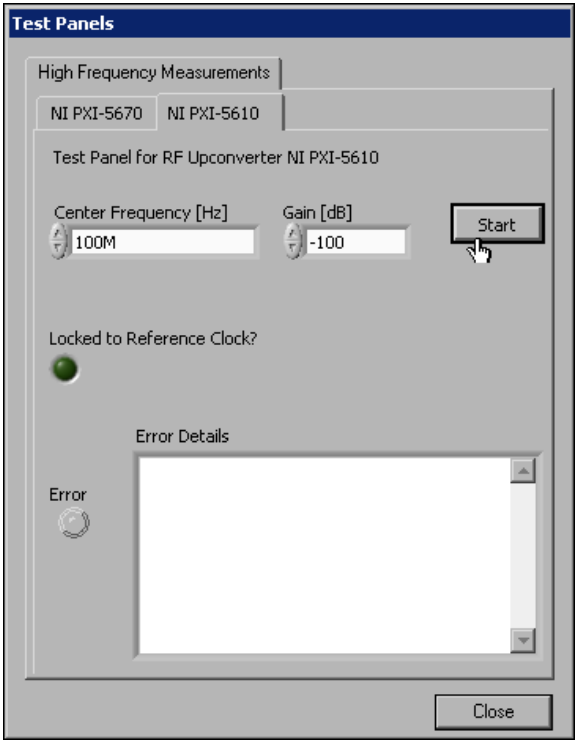


Figure B-4. Click the NI PXI-5610 Tab to View the Upconverter Module Test Panel

11. The **NI PXI-5610** tab verifies PLL locking and proper functioning of the upconverter hardware. Specify center frequency and gain settings.
12. Click **Start** to run the NI 5610 upconverter test panel.

Tip Running the test panel outputs a signal from the RF OUTPUT front panel connector. Disconnect any equipment that may be damaged by the test signal.

13. During operation of the test panel, the ACTIVE LED on the NI 5610 upconverter module front panel is illuminated, and the test panel is displayed as shown in Figure B-5.

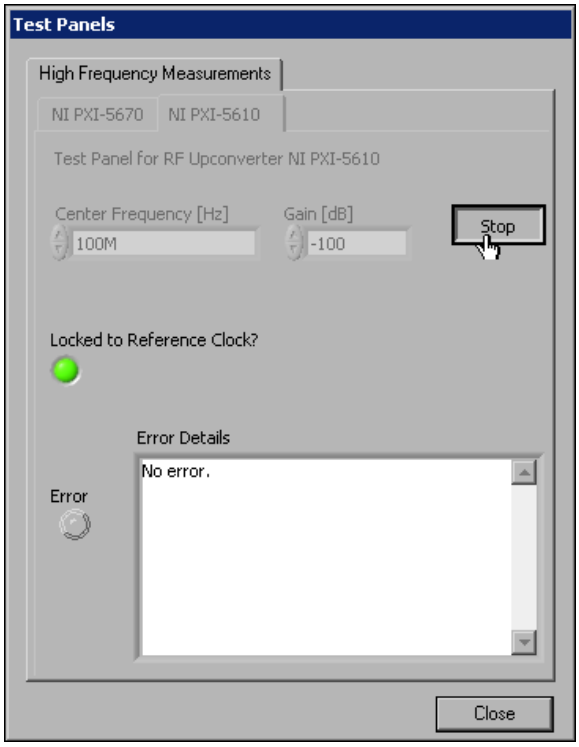


Figure B-5. The NI 5670 Test Panel during Operation

14. Click **Stop** to halt upconverter operation.
15. If the NI 5610 test panel generates an error, power off your system and reinstall the RF Vector Signal Generator software and hardware.

If the NI 5610 test panel does not generate an error, continue with the following steps:

16. Click the **NI PXI-5670** tab to return to the NI 5670 test panel.
17. Click **Start** in the NI 5670 test panel to begin waveform generation and verify proper operation.
18. Click **Stop** to halt signal generation and **Close** to return to the MAX main window.

If the NI 5670 test panel generates errors after successful operation of the NI 5610 test panel, complete steps 19 through 22.

19. In the MAX Configuration tree, right-click **NI PXI-5421** and select **Test Panels** as shown in Figure B-6.

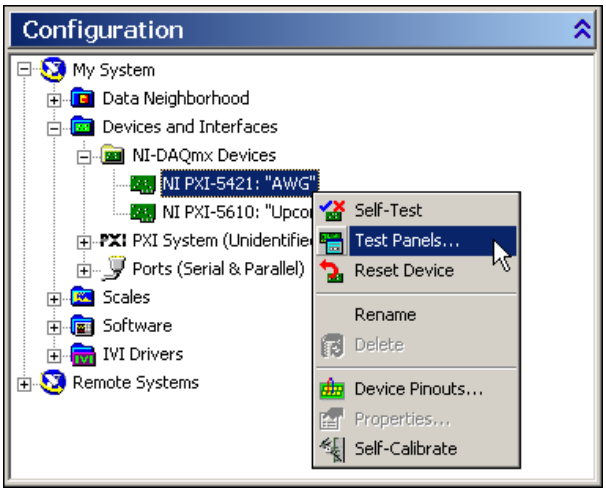


Figure B-6. Open the NI 5421 Test Panel from the NI PXI-5421 Right-Click Menu

20. The NI 5421 test panel (Figure B-7) verifies intermediate frequency (IF) signal generation capabilities. Specify a center frequency in the **Waveform Frequency (Hz)** control.

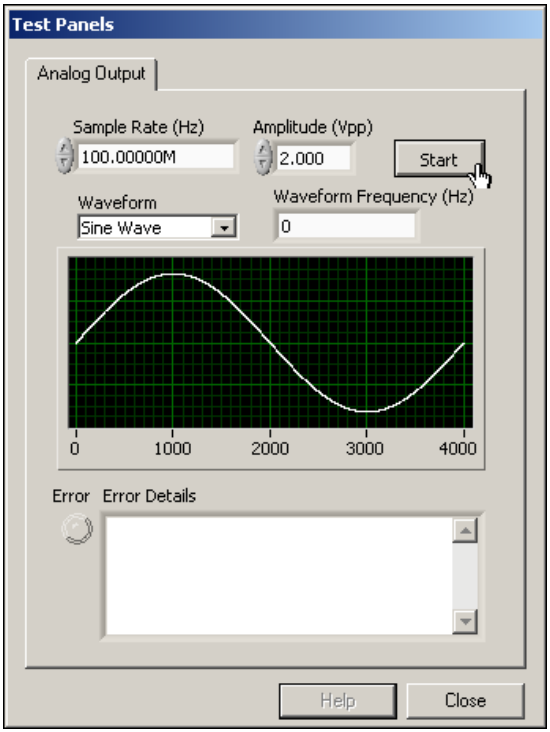


Figure B-7. The NI PXI-5421 AWG Module Test Panel

21. Click **Start** to run the NI 5421 AWG module test panel.

During operation of the test panel, the test panel is displayed as shown in Figure B-8.

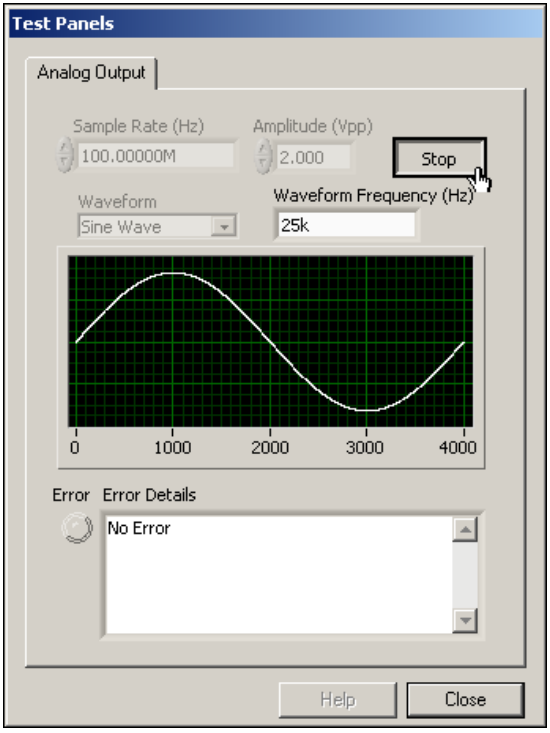


Figure B-8. The NI 5421 Test Panel during Operation

22. Click **Stop** to halt IF signal generation.

If the NI 5421 test panel generates an error, complete steps 23 through 29:

23. Power off your PXI chassis.
24. Disconnect the NI 5670 module front panel coaxial cables.
25. Remove and reinstall your NI 5421 AWG hardware module.
26. Reconnect the NI 5670 front panel cables securely as shown in the *Interconnecting NI 5670 Modules* section of Chapter 1, *Getting Started with the NI 5670*.

27. Power on your system and run the self-test and MAX test panel procedures in the *Configuring the NI 5670 Modules in MAX* section of Chapter 1, *Getting Started with the NI 5670*.
28. If failures continue, contact NI technical support at `ni.com/ask` or call 866-275-6964 and ask to speak to a customer service representative.

C

Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at `ni.com` for technical support and professional services:

- **Support**—Online technical support resources include the following:
  - **Self-Help Resources**—For immediate answers and solutions, visit our extensive library of technical support resources available in English, Japanese, and Spanish at `ni.com/support`. These resources are available for most products at no cost to registered users and include software drivers and updates, a KnowledgeBase, product manuals, step-by-step troubleshooting wizards, conformity documentation, example code, tutorials and application notes, instrument drivers, discussion forums, a measurement glossary, and so on.
  - **Assisted Support Options**—Contact NI engineers and other measurement and automation professionals by visiting `ni.com/support`. Our online system helps you define your question and connects you to the experts by phone, discussion forum, or email.
- **Training**—Visit `ni.com/training` for self-paced tutorials, videos, and interactive CDs. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, NI Alliance Program members can help. To learn more, call your local NI office or visit `ni.com/alliance`.
- **Declaration of Conformity (DoC)**—A DoC is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electronic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting `ni.com/hardref.nsf`.

- **Calibration Certificate**—If your product supports calibration, you can obtain the calibration certificate for your product at `ni.com/calibration`.

If you searched `ni.com` and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of `ni.com/niglobal` to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.